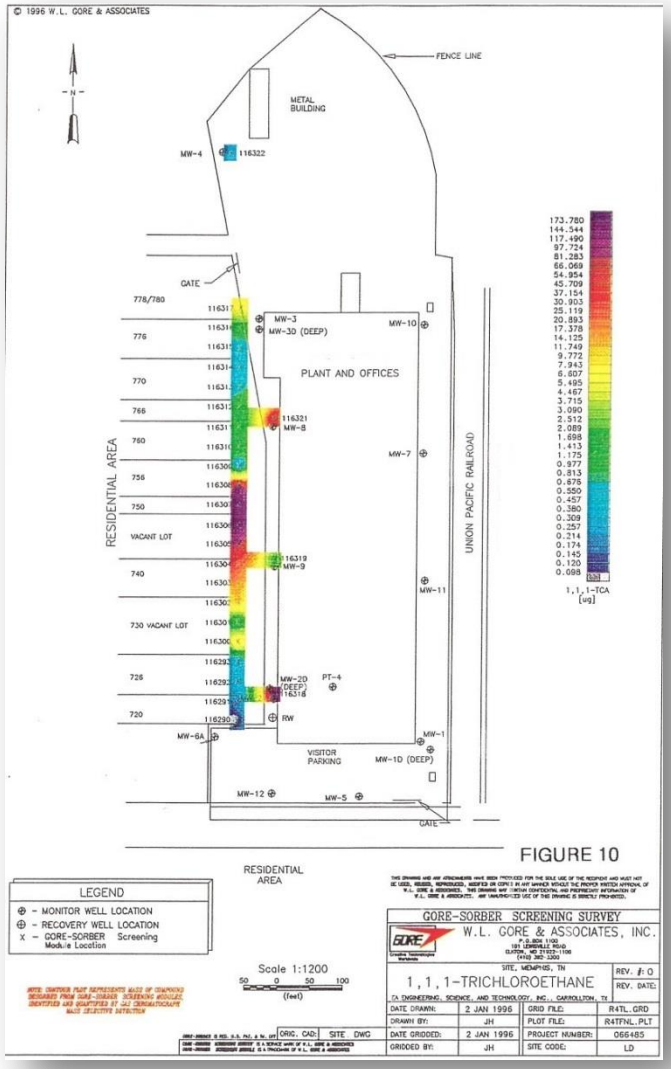
Department of Environment & Conservation

VAPOR INTRUSION (VI)
LESSONS LEARNED IN MEMPHIS, TN

A Brief History

- Mid-1990s: Began requesting assessment of the potential for VI at our sites
- Mid-2000s: Began conducting more EPA and state fund lead sampling activities at our sites
- Needed budget-friendly and more comprehensive initial approaches to assess the presence or absence of VOCs, particularly for fund-lead work

A Brief History: 1995 PSG Survey



Source:
EA Engineering, Science, and Technology
Continuing Remedial Investigation Report
November 1996

A Brief History: 1996 Air Sampling

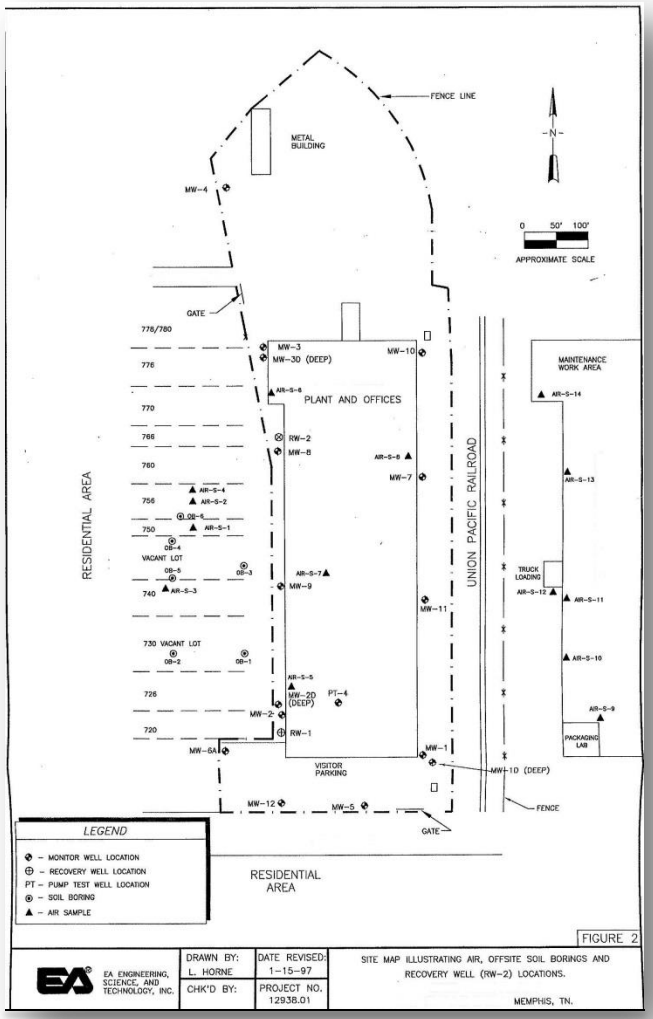


TABLE 3

MEMPHIS, TN
ANALYTICAL RESULTS FOR AIR SAMPLES
8-HOUR DURATION
(ppbv)

Compound	AIR-S-1	AIR-S-2	AIR-S-3	AIR-S-4	AIR-S-5	AIR-S-6	AIR-S-7	AIR-S-7 (Dup)	AIR-S-8	AIR-S-9	AIR-S-10	AIR-S-11	AIR-S-12	AIR-S-13	AIR-S-14	TLV/ TWA
1,1-DCE	<1.3	1.2	<0.94	<0.84	13.0	<0.71	5.3	5.4	1.3	<1.5	<0.86	<0.83	<0.88	<2.9	<3.2	5,000
1,1-DCA	<1.3	<0.76	<0.94	<0.84	2.0	<0.71	<1.4	<1.7	<1.2	<1.5	<0.86	<0.83	<0.88	<2.9	<3.2	100,000
cis-1,2-DCE	<1.3	<0.76	<0.94	<0.84	<1.0	<0.71	<1.4	<1.7	<1.2	<1.5	<0.86	<0.83	<0.88	<2.9	<3.2	N/A
1,1,1-TCA	<1.3	<0.76	<0.94	<0.84	12	<0.71	5.5	5.2	6.6	<1.5	<0.86	<0.83	<0.88	<2.9	<3.2	350,000
1,2-DCA	<1.3	<0.76	<0.94	<0.84	<1.0	<0.71	<1.4	<1.7	<1.2	<1.5	<0.86	<0.83	<0.88	<2.9	<3.2	10,000
TCE	<1.3	<0.76	<0.94	<0.84	<1.0	<0.71	<1.4	<1.7	<1.2	1.8	<0.86	<0.83	<0.88	<2.9	<3.2	50,000
1,1,2-TCA	<1.3	<0.76	<0.94	<0.84	<1.0	<0.71	<1.4	<1.7	<1.2	<1.5	<0.86	<0.83	<0.88	<2.9	<3.2	10,000

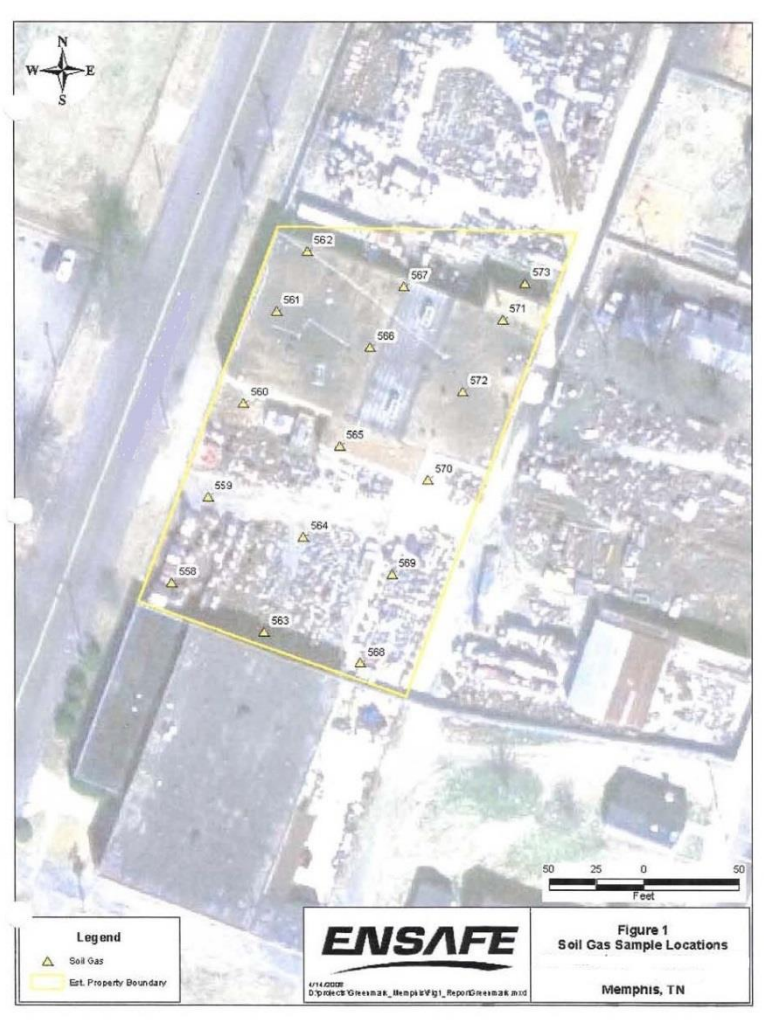
Source: EA Engineering, Science, and Technology
Continuing Remedial Investigation Report
April 1997

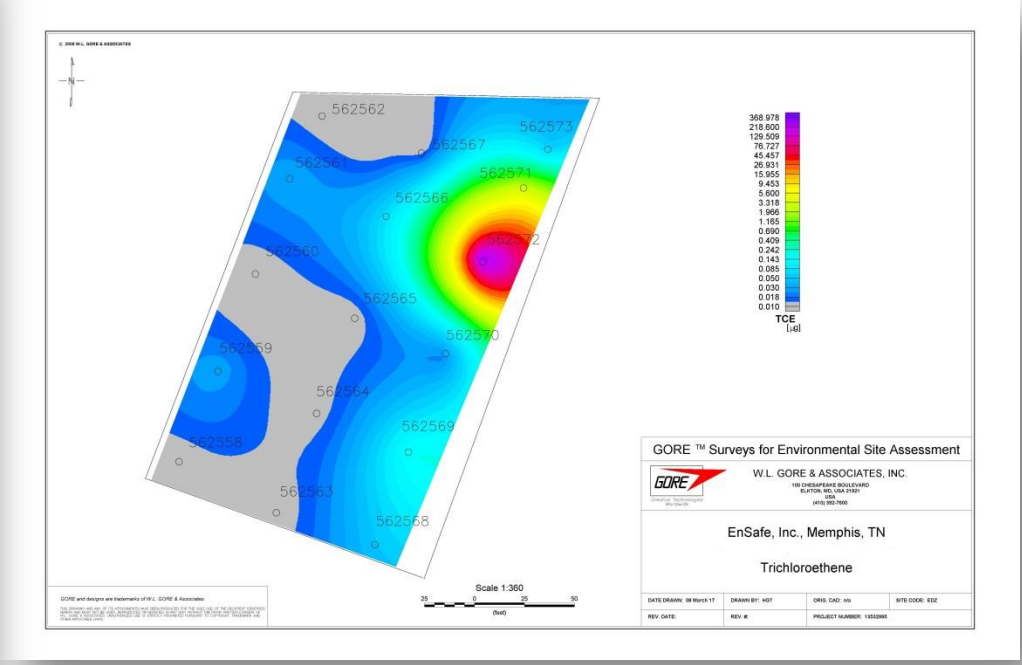
Passive Soil Gas (PSG) Surveys

- Mid-2000s: Began routinely using PSG surveys as initial screening tools for VOC sites
- Helped us to avoid the needle in the haystack approach (i.e. soil sampling for VOCs with no prior data)
- Quickly determined the need and potential locations for additional samples, such as soil, active soil gas, and/or groundwater samples

Disclaimer: We do not endorse any specific product or vendor.

February 2008 PSG Survey



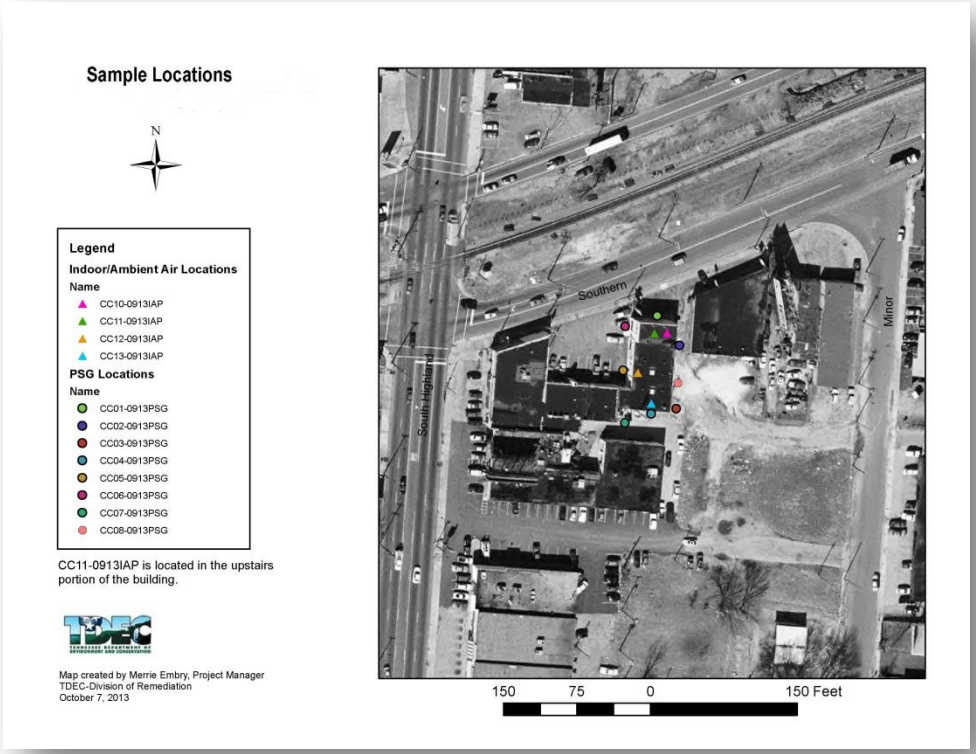


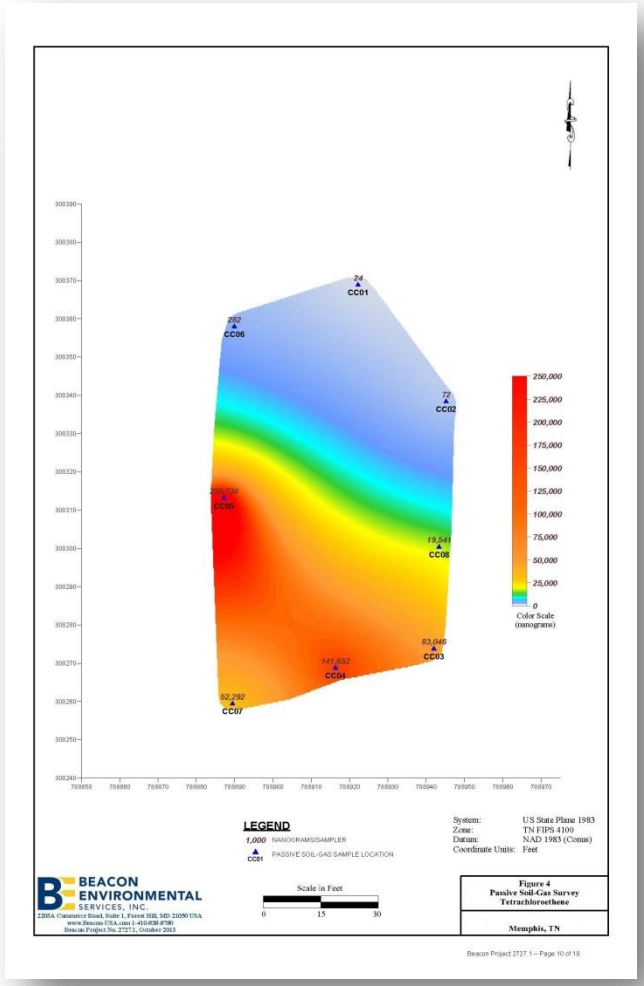
Source: EnSafe, Inc.
Report of Findings Phase II Investigation
May 16, 2008

December 2008 Active Soil Gas Sample Results

- Collected active soil gas sample at PSG TCE hotspot location – 1,200,000 micrograms/cubic meter (ug/m3) TCE
- Groundwater is as shallow as 7-8 ft. below ground surface (BGS) at the site.
- Highest groundwater concentration detected at this location to date is 430 micrograms per liter (ug/L).

2013 PSG Survey PCE Results





Source: Tennessee Department of Environment and Conservation, Division of Remediation
Preliminary Assessment Letter Report
Approved by EPA on June 27, 2014

2015 Soil and Active Soil Gas Results

- Concentrations of PCE in soil at sample location CC05 (PSG hotspot) as high as 1,800 milligrams/kilogram (mg/kg) (9 ft. BGS)
- Concentrations of PCE in soil at sample location CC15 (just east of CC05) as high as 7,100 mg/kg (8 ft. BGS)
- Active soil gas PCE concentration at CC15 - 620,000 ug/m^3
- Groundwater is impacted with PCE downgradient (east) of CC05 and CC15 (140 ug/L).

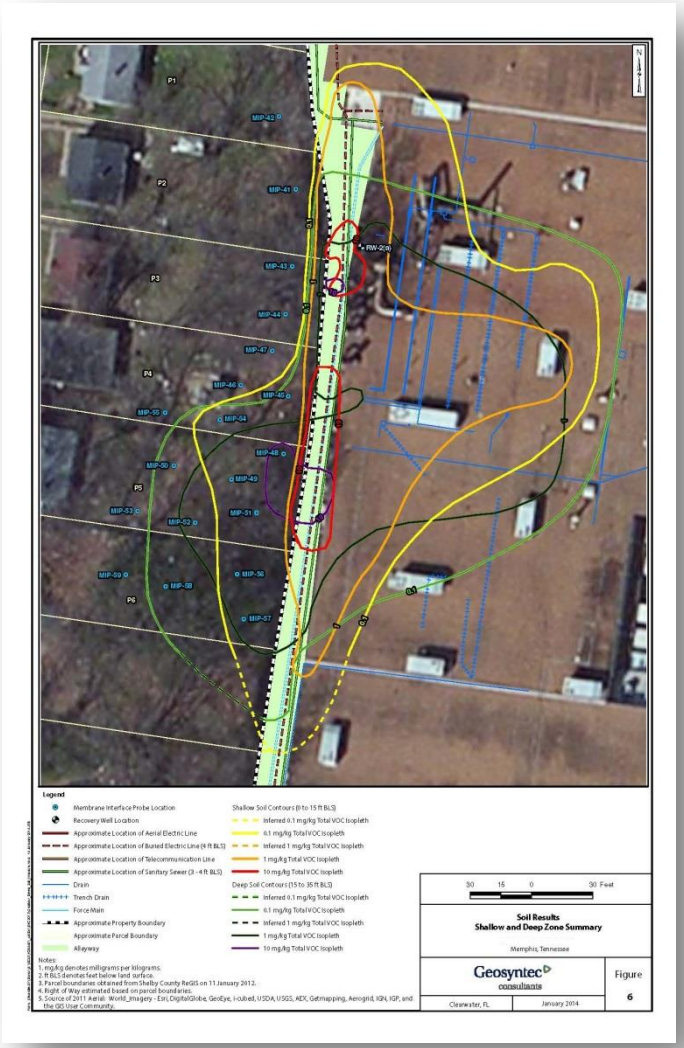
The Importance of Sub-Slab Data

- We did not collect sub-slab PSG data initially during the 2013 sampling activities at the site (i.e. only exterior PSG sample locations).
- Sample location CC15 (just east of CC05) was a sub-slab soil and soil gas sample location in 2015. CC15 was the location of the former dry cleaning machine.
- The highest soil and soil gas concentrations collected to date are at CC15.

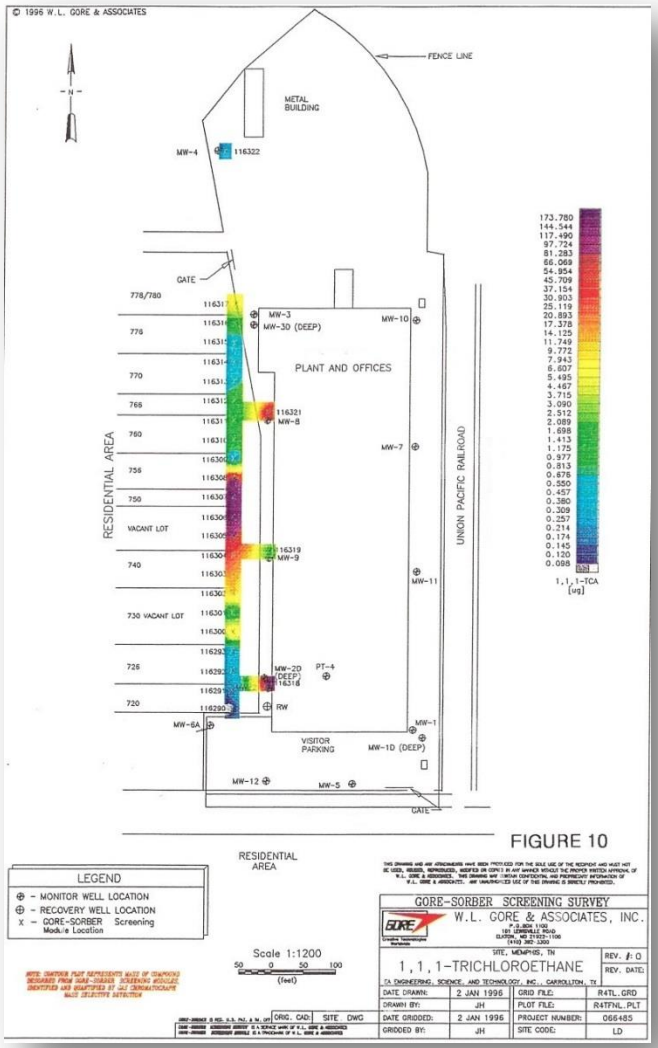
The Trouble with Finding a Source

- The 1995 PSG survey previously shown on slide 3 indicated several hotspots, including one potentially on the mid-west side of the site.
- Numerous soil borings had not fully identified source areas.
- Enter the Membrane Interface Probe (MIP)!

2013 Membrane Interface Probe (MIP) and 1995 PSG Data



Source: GeoSyntec Consultants
August and November 2013
Off-Site Soil and Soil Vapor Assessment Report
January 2014



Source: EA Engineering, Science, and Technology
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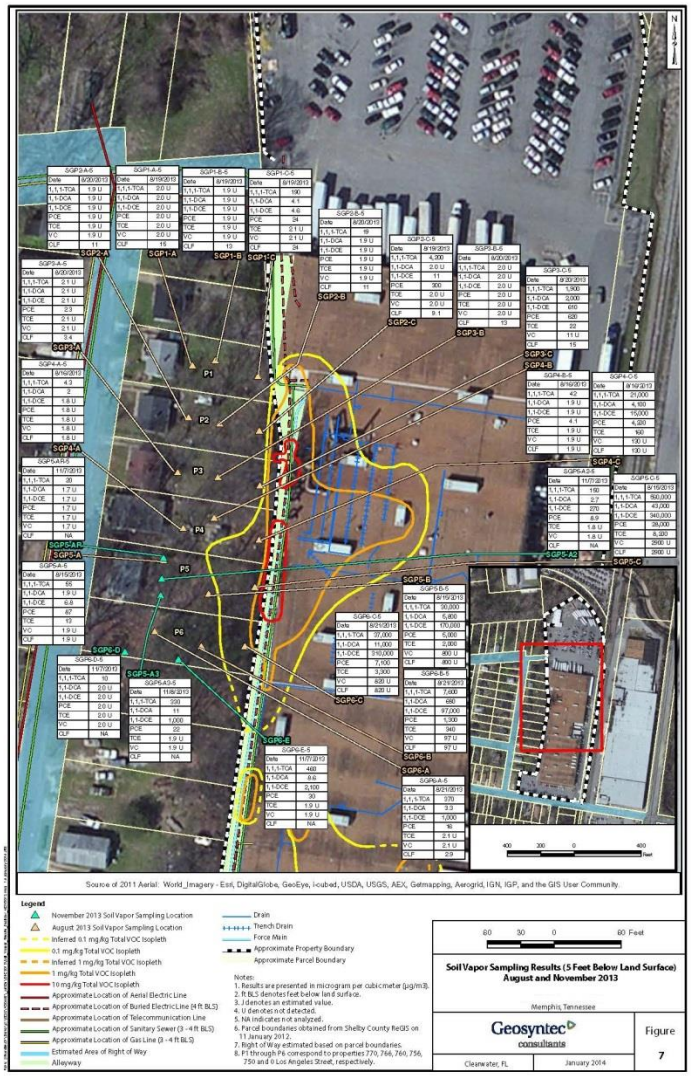
November 1996

Chlorinated Solvent Vapor Migration from a Soil Source



During the 2013 soil vapor assessment activities, elevated concentrations of site-specific chlorinated VOCs were detected in soil gas nearly 100 ft. laterally from the site boundary. The chlorinated VOCs in soil gas on the neighboring properties diffused from the on-site soil source.

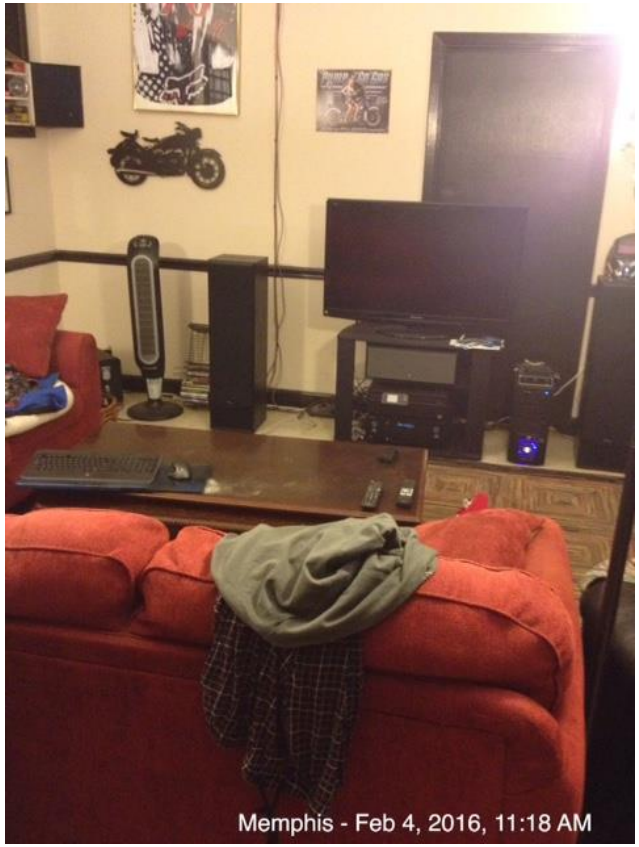
Source:
GeoSyntec Consultants
August and November 2013
Off-Site Soil and Soil Vapor Assessment Report
January 2014

Indoor Air: The All Important Initial Screening/Survey

- Prior to conducting an indoor air sampling event, TDEC DoR now conducts an initial building survey/screening event approximately two weeks prior to the sampling event.
- This allows time for detailed communication with the occupants, identification and removal of potential background sources, and observations of any unexpected conditions.

The Unexpected Residential Receptor

Former Upstairs Living Space
Commercial Building
2013 Indoor Air Event



Living Space
Commercial Building
2016 Indoor Air Event

Lessons Learned – A Summary

- VI investigations moved slowly on historical VOC sites but have now (correctly) become the primary focus of initial investigations.
- Screening tools (ex. PSG surveys, MIPs, etc.) can be very valuable in locating source areas (i.e. finding the needle in the haystack) and help to focus future work on the primary hotspots.
- Collection of sub-slab data (including PSG data) is preferable when buildings are present.
- Vapors can migrate laterally long distances from chlorinated solvent soil sources (~100 ft.).
- Thoroughly assess the building space for more than just background sources of VOCs during the initial survey (i.e. you never know where a residential receptor might be).

THANK YOU